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A 360° Degree Look at Pneumatics

Technology Roundup

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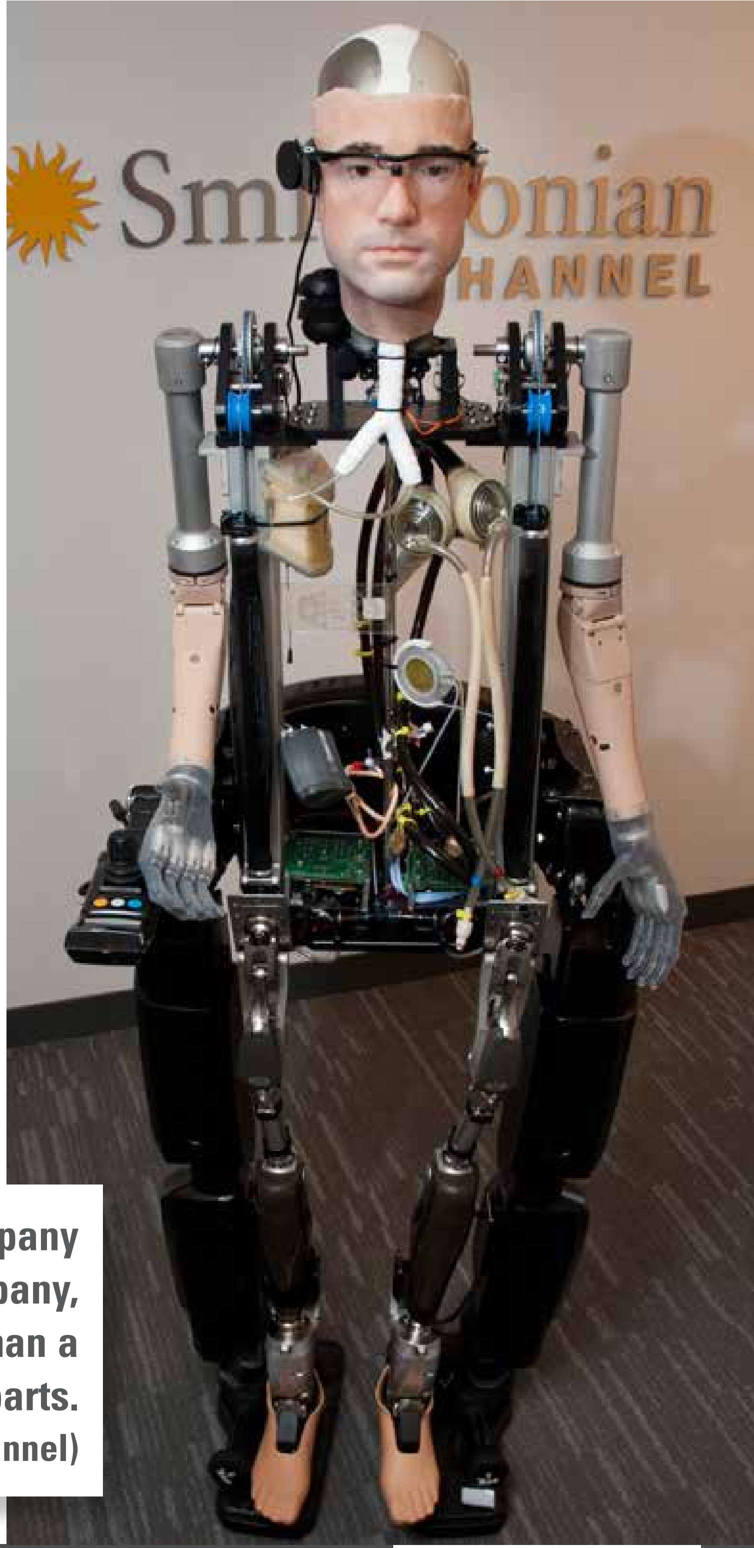
Bionic Man Shows what's Humanly Possible with Artificial Medical Technology

Elizabeth Montalbano, December 10, 2013

In the 1970s, the popular television series the *Six-Million-Dollar Man* featured a man who had been severely injured and then rebuilt with technology, giving him super-human powers he didn't previously possess. Fast forward to 2013, and a London-based robotics company has overseen the development of a Bionic Man in its own right, on a bit of a tighter budget.

The goal of the million-dollar Bionic Man -- the brainchild of London-based television production company Darlow Smithson



The Bionic Man -- an idea spawned by TV production company Darlow Smithson Productions and built by Shadow Robot Company, both in London -- is the product of an effort to recreate as human a machine as possible out of artificial body parts. (Source: The Smithsonian Channel)

Productions and built by Shadow Robot -- was to showcase the cutting edge in medical prosthetics and artificial technology to create as close to a living, breathing human as possible, James Pope, an assistant producer at Darlow Smithson, told Design News. “The idea was that by bringing it all together, these advanced parts, it was mankind’s best shot of building one of its own and getting close to actually building a human being,” he said.

It also was meant to be a showcase for the bleeding edge of medical prosthetics and artificial parts, Rich Walker, managing director for Shadow Robot, told us:

Really the idea was to be able to show what is now possible. When we started doing the project no one really knew how much of a human body was replaceable. The goal was to build something that would show what these parts did and how much of a human is within the capacity of medicine to replicate and replace.

Roots in television

The origin of the Bionic Man came as early as 2010, when Darlow Smithson pitched a program about the latest and greatest in prosthetic and artificial body parts -- which seemed to be all over the news at the time -- to Channel 4 in the UK, Pope said. The channel liked the idea, and Pope -- who wasn’t part of the company at the time -- was brought on due to a minor background in science.

Ultimately, Channel 4 aired a program about the making of the Bionic Man in February 2013. The Smithsonian Channel in the US also was keen on the idea, and is currently airing the *Incredible Bionic Man* program on television and on its website. The robot itself is on display at the Smithsonian Institute in Washington this month, and there are plans for distribution to television stations in Europe as well, according to Pope.

The sum of its parts

The Bionic Man, which has been given the moniker “Frank” -- short for “Frankenstein” -- by its creators, includes 18 unique prosthetics and artificial parts from more than a dozen companies, including skull, eyes, ears, trachea, heart, arms, legs, ankles, and knees. All of the parts are cutting edge and as close to the real human body parts as possible at the moment in the medical industry. The robot's heart, for example -- the Total Artificial Heart from SynCardia Systems -- is capable of pumping 2.5 gallons of blood per minute and can be used as a viable replacement for a human heart, said Don Isaacs, vice president of communication at SynCardia. "It replaces the exact same components in a heart transplant -- the left and right ventricles and four valves," he told us. "It does exactly the same thing as a human heart."

Putting together parts that were made for otherwise healthy human bodies into a machine did pose a bit of a challenge for the Bionic Man's designers, Pope said, particularly in making connections from the parts to a body that didn't have the usual human chemical or structural make-up. "I suppose the biggest challenge was trying to understand how parts that were designed to work with the human body could actually work together," he said. An example of this difficulty came when designers were hooking up the prosthetic hand -- the iLimb from Touch Bionics -- to the robot.

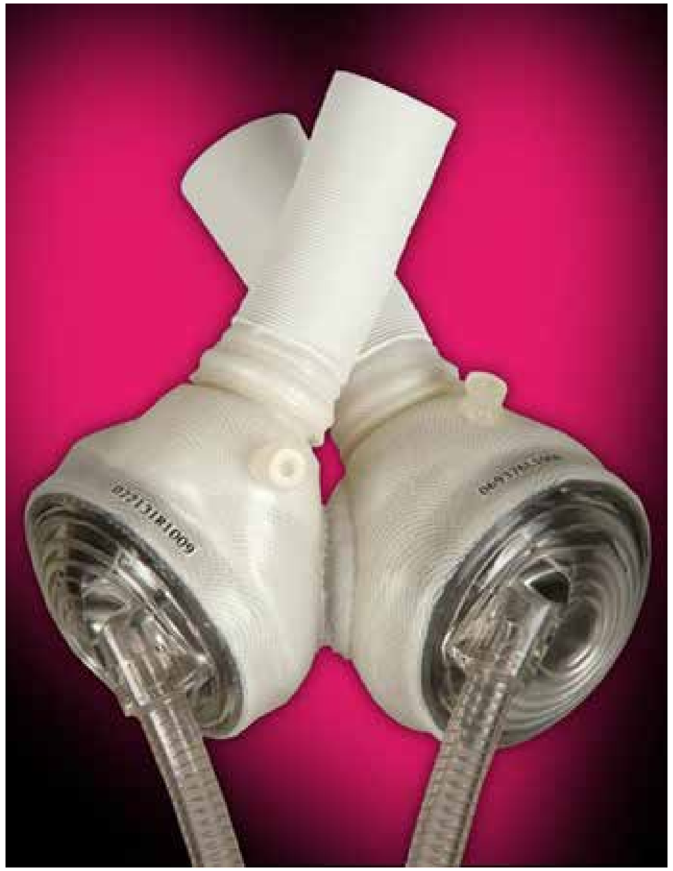
The iLimb is the most advanced bionic hand currently available, with five individually powered, multi-articulating fingers controlled by electrodes that are placed on the surface of the skin and are designed to pick up muscle signal, Karen Hakenson, a communications representative from Touch Bionics, told us. However, because it was designed to work with human nerves, all of this functionality initially was useless on the Bionic Man, she said. "The hand was designed to take a nerve signal from the human body, but of course we didn't have a nerve signal," she said. "We had to build electronics to fake a nerve so the hand could respond to the signal it was expecting."

Not all the parts on the Bionic Man were from manufacturers, however. Some, like the robot's shoulders, had to be custom built to suit the design goals of the robot. Shadow

Robot undertook this challenge itself, constructing a shoulder out of aluminum, a type of plastic called delrin, and a series of 3D-printed parts. "We needed movement in the shoulder for reaching out and grasping something, and there wasn't a prosthetic shoulder that could move," Walker said.

To enable this movement once the shoulder was built, the Bionic Man's designers used a pneumatic muscle running on compressed air to mimic a body muscle, giving the shoulder the range it needed to move backward and forward, Walker said. Another part that needed to be custom built was the robot's circulatory system for moving the fake blood that pumped from the heart.

Walker said he and his team realized this was expertise they didn't have and was a task better left up to a medical expert. They brought in Dr. Alex Seifalian from University College London, who had a more working knowledge of a human body's circula-



The SynCardia Total Artificial Heart was used as the heart for the Bionic Man, pumping blood from each ventricle through the robot's artificial circulatory system at 2.5 gallons per minute. The heart -- which is typically used as a temporary replacement heart for people awaiting heart-transplant surgeries, and then removed once a viable donor human heart is found -- is capable of all of the functions of a normal human heart. The company currently is working to certify the heart as a permanent replacement organ. (Source: SynCardia Systems)

tory system than the robot makers, to build the part of the robot that would pump blood from the heart to its organs. Seifalian, professor of nanotechnology and regenerative medicine, constructed the system with a mixture of plastic piping and artificial blood vessels, Walker said. The completion of the circulatory system gave the Bionic Man the lifeblood and the real-life animation perspective the robot didn't quite have before. "When [Seifalian] filled it with artificial blood and turned the heart on, it was a pretty spooky moment," Walker said.

Almost human

Indeed, all of this construction has left the Bionic Man with some uncanny human-like features. It can walk unaided on its prosthetic legs and talk using a triptych of technologies -- sophisticated chat bot called Eugene Goostman from Princeton Artificial Intelligence, speech recognition software, and a text-to-speech generator of the same ilk as the one used by Steven Hawking, according to Pope.

Because of the speech-recognition technology, the Bionic Man can have conversations with people, using the same colorful language humans sometimes use. "He was sometimes a bit rude and a bit sweary," Pope said. This is likely because the person programming the robot used colorful language in its conversations with the robot, which learned to speak through a combination of both custom programming and also mimicking other people, he said.

Thanks to advanced retinal prostheses from Second Sight and his custom-built shoulder, the Bionic Man could also locate and pick up objects, and even pour a drink, Pope said. In the end, Shadow Robot's Walker concluded that about two thirds of a human body can currently be replaced by the medical industry. "A lot of this technology is really surprisingly impressive," he said. "It has come a long way in the last 10 or 20 years."

An infographic on the website of the Smithsonian Channel shows the various artificial parts of the robot and describes their functions. ■

Enter the Scary Door... If You Dare!

Cabe Atwell, Contributing Editor, ***Design Hardware & Software,*** October 28, 2013

Halloween is a time when kids and adults get the opportunity to step outside themselves and dress up in attire that would be deemed strange any other time of the year.

These attractions have sure come a long way from those back in the '80s when I was growing up. Back then, kids used their imaginations as we ventured through the local haunted houses, which were usually erected in a shopping plaza's parking lot. These were the kind that were built into several semi-trailers that were usually connected together to form several rooms.

The Raspberry Pi & air piston-based Scary Door.
(Source: Cabe Atwell)

The rooms were then outfitted with terrifying glow-in-the-dark ghosts, rubber serpents and spiders, and a host of teenagers made up to look like goblins that were going to drag us to their chamber of horrors.

The technology that made up those attractions is not in the same league as those found in cities across the US in the 21st century. Most of the technology back then consisted of levers and pulleys that would move objects using fishing line. Sure, that's not so scary, but factor in black lighting and strobe lights, and things seemed pretty frightening, especially being 12 to 14 years of age.

Fast-forward to today's multi-million dollar haunts, and the difference in technology is night and day. The pulleys and fishing line have been replaced with pneumatic actuators that allow finely-detailed monsters to move. Gone are the simple black lights -- they've been replaced with IR (infrared) sensors and precision lasers that are able to detect movement and activate horrific props as patrons walk by.

All the technology these places feature (on a large scale) are controlled by a central hub or computer system, which controls everything from haunting sounds to incredibly realistic animatronic displays. For some of the bigger venues, fans are required to sign waivers as they proceed through

the attraction, as well as required to wear an RFID bracelet that not only lets supervisors know your location, but are also used to trigger some of the displays themselves. Technology isn't just centered on large attractions alone -- home-brew haunted houses are taking advantage of it as well.

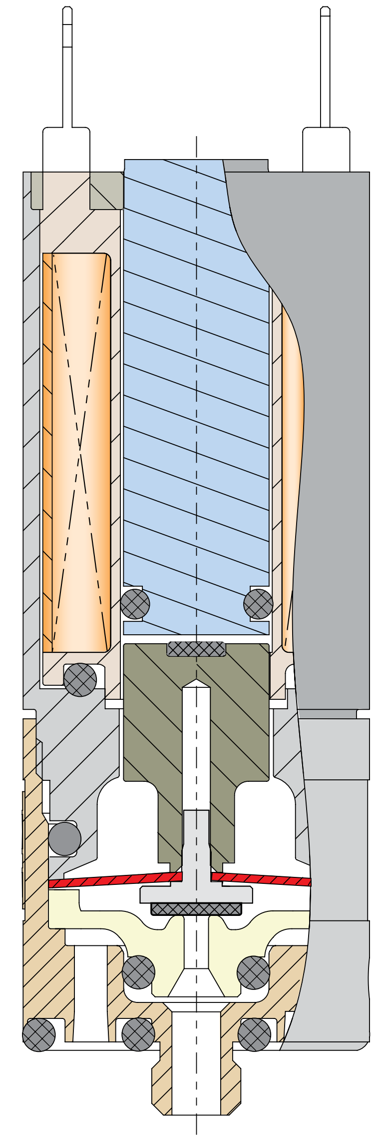
My Scary Door project is a prime example of how new technology is being implemented in at-home attractions. The door was designed using a 24-inch monitor that displays Halloween-themed videos embedded in a creepy sheet-metal laden door. Outfitted behind the door is a system of pistons and solenoid valves that strike the sheet metal in time with the video being displayed to create the simulation that someone (or something) is beating on the door. Trick-or-treaters engage the door's scariness by triggering a Seco-Larm Enforcer break-beam device situated several yards before getting to the door itself. Controlling the show are two Raspberry Pi SBCs, with one for controlling the video output and the other, combined with a PiFace, for implementing the relays that fire the pistons. C and C++ code bind everything together for a technology-based haunted device that is capable of scaring the most reserved children looking to get their Halloween candy.

It's easy to understand why scaring people is big business, as the revenue generated each year for these haunted attractions can easily be in the billions. This creates healthy competition for those who design such attractions to be the scariest in the nation. It's most assured that as technology advances, so will our fears, which seem to grow as Halloween draws near and we venture through the "Scary Door"!

Want to build your own Scary Door? Find all the parts/build instructions here. ■

Clippard's New DV Valve High Flow in a Miniature Package!

Clippard Instrument Laboratory, Inc., Manufacturers of Pneumatic & Electronic Control Devices



Clippard's entry into the miniature electronic valve market began in 1973, when Leonard Clippard, founder, introduced the EV line of valves which utilized only one moving part, the "spider". Today, the EV valve is still serving a very horizontal market with thousands of installed applications in a multitude of industries. Since the initial introduction, several new series have been added to the line, including; Corrosion-Resistant, Oxygen Clean, Analytical, ECN, EVN, ETN, Proportional Control, Intrinsically Safe, EM and ES series, all utilizing the "spider" design. Enter the New DV Valve.

New Design Challenges

According to Dave McBreen, the DV valve project design engineer at Clippard, the all new design began with the coil. "It's not that we designed the valve around the coil", said Dave, "but we knew our design parameters called for the coil to be less than 2.0 watts, so we began there. The 2.0 watts would allow us to see what kind of magnetic pull we could generate". Dave goes on to say that many coils were made in the attempt to optimize one. This led to an optimized solenoid needed for the valve. The process for determining the correct coil was enhanced by a coil calculator. The calculator, which was designed by Clippard's engineering department, greatly reduced the design time and provided the exact specifications of the coil.

Once he had the design criteria, Dave felt as though his biggest challenge was to consider the manufacturing processes needed to get the product out the door. How to get a cost-effective, optimized design through manufacturing and yet be fairly simple to assemble was the challenge. Included in this thought process was the concern with size limitations; the valve needed to be small. Yet, he had other criteria to consider, including; power, flow, pressure and materials.

The requirement from the very beginning called for all metal parts to be stainless steel with the nozzle and bobbin utilizing certain plastics that would allow for FDA approval. The all stainless housing provides many environmental advantages and is manufactured in three parts. Dave is very enthused about the three-part design and just what a "robust package" it delivers. "It can be taken apart and put back together in seconds, said McBreen. One of the main reasons for this is that the valve only has one moving part…the "spider."

The all new spider, designed from stainless steel, is capable of flows to 100 1/min at 100 psig. Although this is a new spider design, compared to the existing EV line, it is still a poppet valve. With a preload of approximately 0.017", stroke up to 0.018", and response time of 10-15 milliseconds, the DV Series can be utilized in many applications. And, with the over-molded seal, the DV Series will continue the high standard set by the industry leading EV line for leak-free operation, which is particularly meaningful for analytical applications.

McBreen also noted that, "in addition to being very economical to

produce, the straight-forward, robust design leads to a hassle free assembly. The new valve has another feature not readily found in other miniature valves: bi-directional flow. It is designed to serve as a dual flow valve within a certain pressure range. Applications requiring this feature should be discussed with Clippard's technical staff prior to installation".

Manufacturing

After two years of building prototypes and testing (using FEA stress analysis on the spider and magnetic analysis software for the valve) it is now being marketed, according to McBreen. Initially the product is offered with an orifice of 0.052" or 0.070", with manifold or cartridge style mounts, and voltages in 12 and 24 VDC. Air and other compatible gases are the recommended media with the standard seal but other seals are available for use with other medias. Simply by changing the coil, nozzle orifice, or mounting options, helps to enable customer special applications.

The DV line is assembled in Clippard's Fairfield, Ohio plant along with the EV line and other Minimatic® electronic valves where, according to Steve Schutte, Plant Manager, "all work cells and personnel are prepared for a very positive response to this new product. The ability to produce thousands of valves per week is due in no small part to the straightforward design, which means a straightforward assembly. In addition, an automatic tester is in place which ensures 100% of the valves go through the testing process." He also noted the testing equipment was designed and built by Clippard.

Application Potential

Now that the design and manufacturing processes have been finalized, where will the valve be used? According to Rob Clippard, vice president sales & marketing at Clippard, "one of the key applications will be in the medical field. Although there are numerous applications within the medical industry, none will be more applicable for this valve than blood pressure cuffs. Additionally, applications requiring some sort of pressure monitoring, pulse monitoring of the heart or perhaps oxygen therapy have a great amount of potential. With its high flow capability, respirator applications will definitely be one of the most common uses. Other applications in the medical field would include ventilator and kidney dialysis machines."

Yes, medical is a primary market, according to Rob, but there are many other applications and markets, including gas chromatography, liquid chromatography-mass spectrometry, and other applications requiring analysis. He noted the valves would be used throughout the packaging industry, especially where small banks of manifold mounted valves would be needed.

Future Development

So, what's ahead for the DV valve? According to John Campbell, President, "this is one of the new generational valves and we believe it will contribute to the success of the company for a long time. From this basic design we expect to be successful from the start; we'll be growing into many other products as we continue to invest in engineering and continue to believe in new product development as the key to our future." ■

Pneumatic-Based Trash Disposal System Eyed in NYC

Elizabeth Montalbano, Contributing Writer, October 21, 2013

Researchers in New York City are studying the idea of creating a pneumatic-tube-based trash disposal system that will transport waste out of the city through a system of tubes.

The proposal by researchers at the University Transportation Research Center (UTRC) at the City University of New York envisions a series of tubes, both underground and above ground, to take solid waste out of the city, eliminating the bag-and-truck-based system the city uses now. The idea was covered in a feasibility study researchers at the organization put together.

New York City already has such a pneumatic tube-based system on Roosevelt Island, a planned community in the East River that opened in 1975, Benjamin Miller, a senior research fellow for freight programs at the UTRC and former director of policy planning for the New York City Department of Sanitation, told Design News. There are also hundreds of pneumatic tube-based waste disposal systems in other parts of the world, including the Spanish cities of Barcelona and Seville, Paris, and the Wembley part of London, said Miller, who co-authored the feasibility study.

The initial locations for the system in New York would be in two places. One would be to install the tube along part of the under-construction Second Avenue subway line between 92nd and 96th streets, while the other would be an installation as part of the supporting framework of the High Line, an elevated city park on the city's west side in the Chelsea neighborhood. The Second Avenue section would service buildings in that area, while the High Line section of the system would remove waste from the park itself as well as the Chelsea Market building, which is home to hundreds of businesses, Miller told us.

The idea is to install the system incrementally and connect the pipes like Legos, since installing a system citywide would be cost-prohibitively expensive, Miller said. "The system

The system would be a series of small systems about a mile or so long and then you snap them all together like Legos

would be a series of small systems about a mile or so long and then you snap them all together like Legos," he told us. "To build it all at once would be like building sewers if New York never had them, which would cost hundreds of billions of dollars."

Mechanically, the system works like this: People in a building or on the street in a certain area deposit waste in various bins, or "inlets," with a reservoir at the bottom that connect to a pneumatic tube. There will be separate inlets for different kinds of waste, including different types of recyclable material, organic waste, and household refuse.

The waste is dropped into a reservoir at the bottom of the inlet that is connected to a pneumatically powered trunk tube with a fan that pulls air at a speed of 60 miles per hour, Miller explained. When the reservoir is full, a valve is opened from a control point at a central terminal and suctions the waste into the terminal for separation and eventual disposal through a large container that is picked up by a truck and deposited at a landfill or other disposal facility.

In an urban area like New York, the pneumatic tube would eliminate a lot of the pollution, costs, and other negative aspects of the current waste-disposal system, Miller said:

Garbage trucks are an enormous part of the problem. Moving that stuff is expensive, and there are a lot of problems associated with trucks like fuel, noise, odors, and traffic congestion. This avoids all of those obvious economic, environmental, and quality of life issues, and makes the overall system easier to manage.

Now that Miller and his colleagues have concluded the idea is feasible, they are looking for a contractor to build the system. "It is feasible, operationally, economically, and there are environmental benefits," he said. "Now we need to find someone who is willing to agree to do this and pay the upfront operating costs."

Each of the branch systems proposed would cost about $10 million to $11 million to build. The Second Avenue system would transport about 20 tons of waste out of the city, while the High Line system would transfer about 10 tons. However, there is the possibility to transfer much more waste, as these targeted areas and amounts were considered for the sake of the study, Miller said. ■

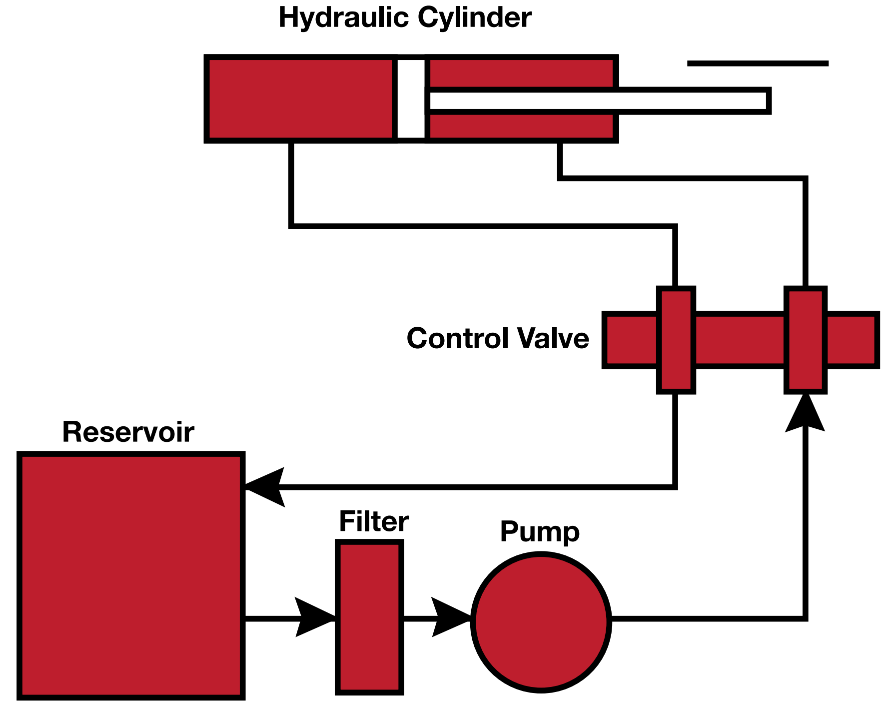
Energy-Efficient Actuation

David Hansen and Michael Foster, *Exlar,* August 15, 2013

Linear actuation is an essential technology that has supported manufacturing operations around the world since the beginning of the industrialized age. Converting energy into useful work has been and continues to be an enabling, challenging, and costly factor in manufacturing operations.

Today, the conversion of raw energy into a controlled linear force is a critical factor in industries with a historically high content of automation, such as automotive, packaging, and material handling. Escalating concerns over the cost and availability of energy, however, are now causing designers in many other industries such as oil and gas, defense, marine, mobile equipment, and entertainment to take a fresh look at energy-efficient electromechanical actuation technologies to replace traditional hydraulic and pneumatic solutions.

Based on US Department of Energy studies, industrial users consume approximately 20 percent of the electrical power generated in the US, and



Although systems are extremely power-dense, hydraulic actuators have the lowest energy conversion efficiency of the three actuator types. (Source: Exlar)

40 percent globally. Furthermore, the studies indicate that 40 percent of industrial applications do not use energy-efficient technologies, intensifying the energy consumption issue. Transportation consumes more than 25 percent of US electrical power.

Clearly, energy-efficient actuation technology has an important role to play in the reduction of energy consumption and resulting emissions.

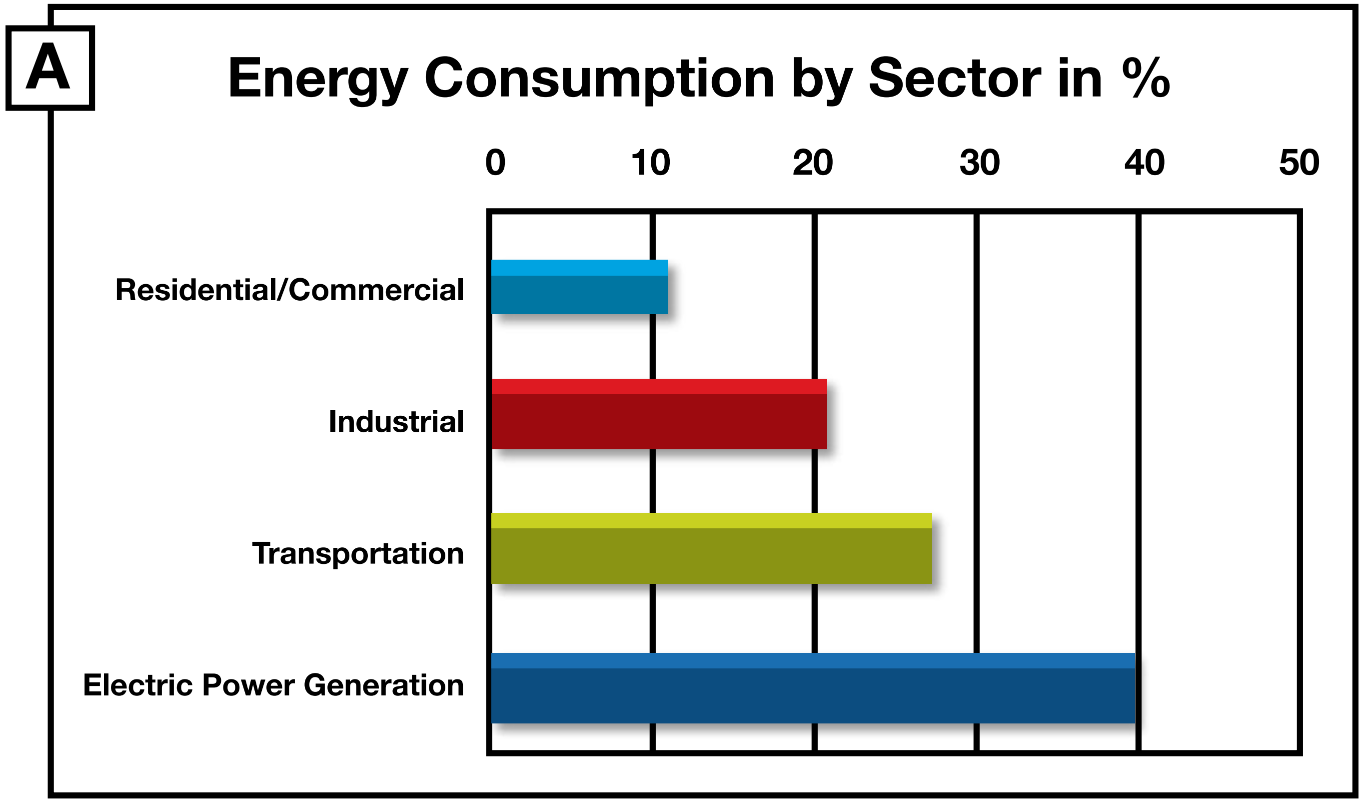
Global competition for resources

Competition for energy resources continues to increase among developing nations around the globe. Growing energy demand and fossil fuel shortages makes reliable, affordable, and environmentally responsible electric power generation and delivery a critical, potentially limiting factor in modern societies. Actuation system design and implementation is increasingly affected by these global energy trends and shortages. At the same time, actuator technology and application development is becoming an increasingly important player in the efficient use of energy.

European countries, particularly Germany, have taken a proactive stance on energy use by introducing the Future Energy Concept intended to address energy resource competition, an increasing standard of living and overall energy consumption. The concept assumes that progress can be achieved through the application of renewable energy sources like wind or bio energy. However, alternative energy sources are not yet capable of adding the capacity needed to cover all energy needs. The concept scope also includes improvements in energy efficiency and that all possible residential and industrial uses must be considered. Studies project a potential of savings of 10 billion€ per year in German industry.

Current actuator technologies

Current linear actuator technologies include hydraulic, pneumatic, and electromechanical systems. Each has a long application history and each has experienced significant technological improvement over time. They differ markedly in the areas of precision, potential work output, system cost, energy consumption, maintenance, emission byproducts, scaling, and other factors. And while historically overlooked, Total-Cost-of-Ownership (TCO) is quickly becoming a major factor in the actuator system buying decision, primarily due to heightened awareness of the impact that the cost of energy required for operation has over the life of the machine. This, obviously, drives bottom line business decisions. Research has shown that more than 95 percent of TCO can be the energy cost to operate an actuator-driven system. Clearly, energy cost estimates can dominate the selection process for any actuator application.



Transportation and industrial energy usage accounts for almost half of US energy consumption.
(Source: US Department of Energy)

Hydraulic actuation

Hydraulic actuators use a hydraulic pump to supply a regulated flow of fluid (usually oil) to the hydraulic cylinder to move the piston. The piston stroke serves as the actuator. Because the fluids are essentially incompressible, hydraulic actuators can produce considerable power in a very compact package. Hydraulic actuators are often used in applications where very heavy loads must be moved and/or where high forces must be applied. Off-highway construction equipment, for example, relies almost exclusively on hydraulic actuators.

Because the hydraulic pump can be mechanically or electrically driven, hydraulic actuators offer a simple solution in the mobile industry where an internal combustion engine already exists on the vehicle to provide the energy required to drive the pump. Although extremely power-dense, hydraulic actuators have the lowest energy conversion efficiency of the three actuator types. And, while they provide better positioning accuracy when compared to a pneumatic actuator system, matching the precision and control offered by electromechanical actuators can be difficult.

Another disadvantage with hydraulic systems is the ongoing maintenance cost and downtime associated with maintaining fluid quality and addressing fluid leaks, not to mention having to deal with the environmental impact from leaks and fluid waste disposal. Additional disadvantages include proportionally greater system weight when compared to pneumatic and electromechanical actuator systems, and the fact that hydraulic actuators require power and pressure to retain actuator position. This often results in higher energy consumption, even when the application or machine is at rest or holding position.

Pneumatic actuation

Pneumatic actuators use pressurized air or other gas, usually supplied by a compressor, to drive a piston within a cylinder. Pneumatic actuators are ideally suited to moving light loads with a quick, repetitive motion. Pneumatic actuators produce relatively low work forces and do not operate as precisely as hydraulic or electromechanical actuators. Application examples include nail guns, part ejection, clamping, and robotic end effectors. The internal combustion engine is basically a pneumatic actuator.

Of the three actuator technologies, pneumatic actuators occupy the middle ground in energy conversion efficiency. Pneumatic actuator component costs are typically low. However, the cost of installing and maintaining compressed air sources and the cost of producing compressed air or gas can add significantly to the TCO of a pneumatic actuator solution. For example, a ¼-inch diameter air leak can consume an additional $9,000 per year in energy costs. And like hydraulic systems, pneumatic systems require continual maintenance to repair air leaks and to ensure a clean, dry supply of air. Pneumatic systems are also extremely noisy.

Electromechanical actuation

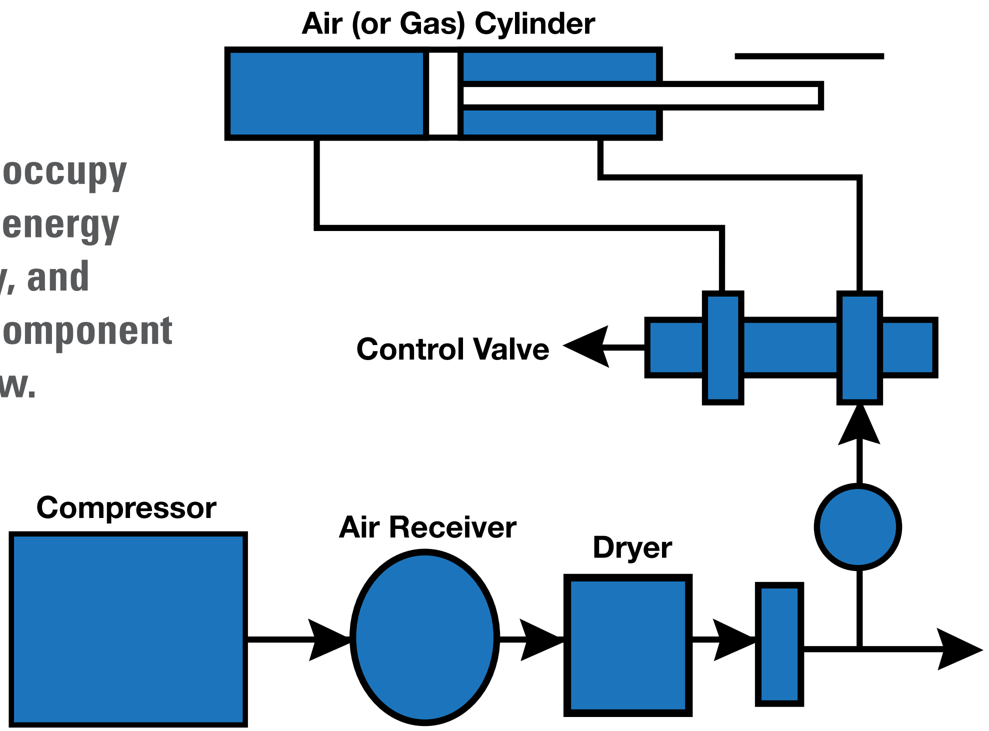
Electromechanical actuators convert rotary motion to linear force via an electric motor (servo, stepper, DC brushed, or induction) driving a mechanical linkage, such as a roller screw. The roller screw converts the motor's rotary motion into linear motion. The motor is either directly coupled to the roller screw by a flexible coupling or through some type of power transmission, such as timing belts or gears.

Exlar's GS Series linear actuators take this concept a step further and integrate a servo motor directly with a roller screw. This design concept results in an electromechanical actuator with a form factor similar to a hydraulic cylinder to simplify migration from one technology to the other, and enables the use of a wide range of mounting and installation options. The Exlar Tritex line of actuators integrates the motion controller and servo drive into one package for additional compactness and system simplicity.

Electromechanical systems have several advantages compared to both hydraulic and pneumatic solutions. Fewer or no components are needed between the power source and the actuation component. This allows much higher energy efficiency when compared to hydraulic and pneumatic technologies. Because the electromechanical actuator power source and control components can be enclosed within the actuator package, the actuator system profile, space requirements, and installation are often simpler than hydraulic or pneumatic actuator systems. This has a favorable impact on installation time, cost, and efficiency of the actuator within the larger mechanical system.

Electromechanical actuator systems provide positioning accuracy and repeatability superior to that of pneumatic and hydraulic systems. Pneumatic actuator systems can experience wide pressure variations that result from the inherent compressibility of gases and the change in air density with temperature, resulting in a significant amount of overshoot and oscillation and drift over time. For this reason, pneumatic actuators are rarely used for precision positioning applications. Hydraulic actuators rely on fluids that are basically non-compressible, and can therefore provide acceptable positioning for low accuracy applications, but line swelling, temperature variation, and other factors affect positioning accuracy similar to pneumatic systems.

With no fluid compressibility issues



Pneumatic actuators occupy the middle ground in energy conversion efficiency, and pneumatic actuator component costs are typically low.
(Source: Exlar)

to contend with, electromechanical actuator systems are inherently very stiff and can therefore position the load very accurately and repeatedly with little or no overshoot or oscillation. Consequently, electromechanical actuators can be controlled very precisely and settle quickly at the end of the move which shortens cycle time. Electromechanical actuators, therefore, are significantly more consistent, predictable, and precise than either pneumatic or hydraulic actuators, which enhances their overall efficiency.

Specific electromechanical actuator advantages include:

- Ease of installation. Quick connect cables require far less time for installation compared to pneumatic and hydraulic system plumbing.
- Electromechanical actuators offer simpler system tuning and synchronization, reducing time to commission the system.
- The physical size of an electric system is much smaller than a hydraulic system due to the elimination of hydraulic power packs and reservoirs.
- Draws power only when producing work, unlike hydraulic systems.
- Cleaner, environmentally friendly and safer operation. No hazardous waste byproduct control or disposal; No pressure leak dangers; No fire risks from flammable oils in high temperature applications.
- Less maintenance in comparison to hydraulic and pneumatic actuators. No fluid reservoirs to check or filters to replace; No fluid tests, hoses or seal repairs.
- Virtually silent operation, making it easier to comply with health and safety directives.
- Longer tool life due to better load control. Electromechanical actuator precision and control reduces stress on machine parts compared to those driven with hydraulics.
- Higher cycle rates through faster settling times compared to hydraulics.
- Significantly lower energy consumption/cost.

Actuator technology efficiencies

As previously stated, up to 95 percent of the TCO of an actuator system can be the direct and indirect consumption of energy required to operate the actuator. Energy consumption, therefore, presents the most significant actuator technology differentiator with regard to short and long-term cost implications and a return on investment evaluation.

Two major evaluation considerations exist:

- The typical energy consumption of each actuator technology.
- The ability of each actuator technology to efficiently deliver work energy to dependent systems.

A recent independent study conducted by the University of Kassel (UNI-Kassel), Germany, compared hydraulic, pneumatic, and electromechanical actuation systems. The study evaluated each system using identical workload and duty cycle conditions. The objective was to determine the energy required by each actuator system to move a 100 kg load. The energy required for the pneumatic actuator No. 1 (powered by a compressor that used 120Wh for the compression of one cubic meter of air), was measured with a calorimetric airflow device. The energy required for the hydraulic actuator No. 2 was determined by a flow counter (measured flow, calculated energy consumption using a factor of 1.6 kWh per cubic meter). The energy required by the electromechanical actuator No. 3 (including the control unit), was measured with an electric meter. Standard hydraulic and pneumatic components were used. The electromechanical actuator was an integrated Tritex II actuator from Exlar.

The experiment results indicated that the hydraulic actuator system's energy conversion efficiency was 57 percent, the pneumatic actuator system's efficiency was 77 percent, and the electromechanical actuator system's efficiency was 90 percent efficient.

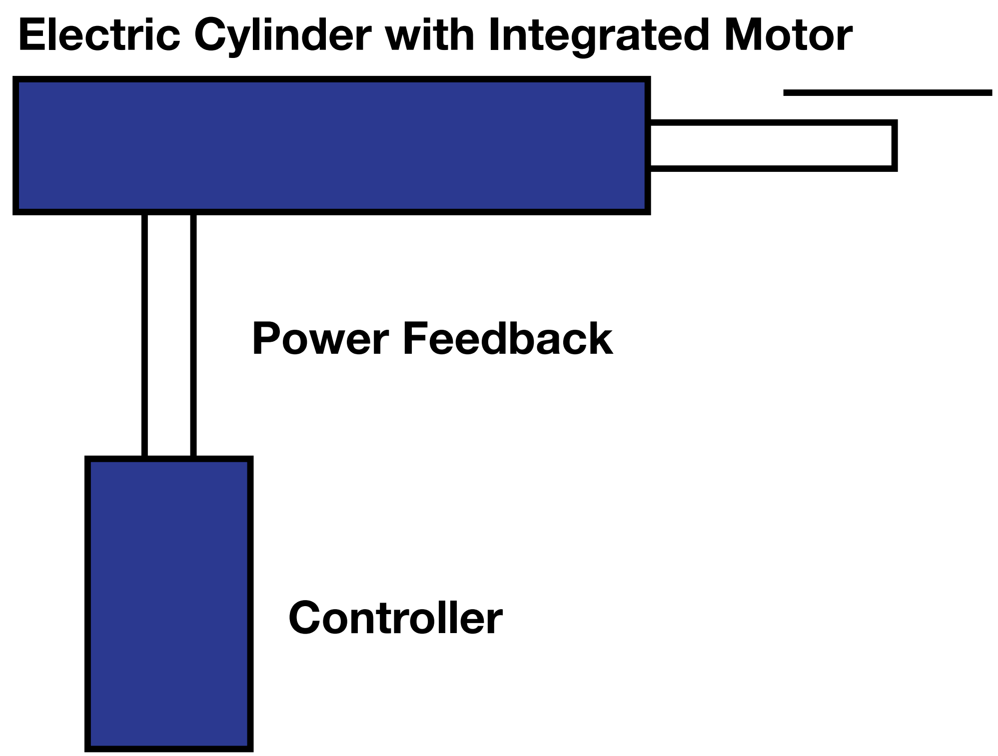
The measured consumption of energy by each actuator type was multiplied by a factor of 6,000 operating hours per year (typical duty cycle within in a factory automation setting). The energy consumption estimates for each actuator type based on those 6,000 operating hours year are:

- Hydraulic: 8,380 Kwh/year
- Pneumatic: 3,602 Kw h/year
- Electric: 816 Kw h/year

Estimated CO_2 emissions from the three actuator systems are:

- Hydraulic: 2.3 metric tons/year
- Pneumatic: 5.3 metric tons/year
- Electric: 525 kg/year

Comparing all, the electromechanical actuator system produces 77 percent less CO_2 than the hydraulic and 90 percent less CO_2 than the pneumatic. The study estimated and compared total yearly energy consumption of each actuator system. All factors considered, the hydraulic actuator system required 4.4 times more energy than the electromechanical actuator system and the pneumatic required 10 times more energy.



Electromechanical systems offer a simplified mechanical solution, and fewer or no components are needed between the power source and the actuation component, which can create much higher energy efficiency.
(Source: Exlar)

Electromechanical actuator efficiency

As concern over the cost impact of energy consumption on the bottom line continues to grow, targeting improvements in this area is gaining strategic focus. Based on research conducted by Energy Efficiency & Technology Magazine, 94 percent of respondents to their survey indicated more energy saving programs would be initiated over a two-year period.

With their force handling capabilities, precision, and higher efficiencies, electromechanical actuation systems can provide potential energy savings and benefits over a wide range of applications in industrial and harsh applications. Electromechanical actuators eliminate the need for supporting sub-systems such as compressors, pumps, fluid maintenance, etc. to provide not only energy efficiency, but also less environmental impact and potentially lower total life-cycle cost.

When combining other benefits such as scalability, lower installation, maintenance costs, and higher productivity, the return-on-investment from adopting or conversion to electromechanical actuation can make a compelling business case.

David Hansen is marketing manager and Michael Foster is a consultant for Exlar.

The Many Faces of Manufacturing Efficiency

Rob Spiegel, Senior Editor, ***Automation & Motion Control,*** November 29, 2013

North American plants are becoming more efficient. While the term lean manufacturing once had a very specific meaning at plants like Toyota with its quality circles, now the term has come to mean any technique that brings efficiency and optimization to the manufacturing process. This goal is to improve throughput while reducing waste, to improve uptime while reducing energy consumption, to improve safety while reducing work stoppages.

Gains in manufacturing efficiency and automation means that logistics play a larger role in choosing a location for a plant. If your manufacturing is efficient in Ohio, you will be less likely to locate your plant in China. What you save in cheap overseas labor will be eaten up by shipping. The idea of keeping your manufacturing close to home works only if you can make sure your processes are very lean. We're seeing new progress on a wide range of plant processes.

Less hardware and more software

One of the trends we're seeing in lean processes is an increase of reliance on software and the trimming down of hardware. "How can you do more with less? If you have more functions with one controller instead of many controllers, you'll be more efficient," Graham Harris, president of Beckhoff Automation, told Design News. "You can control a machine with three axes with one controller. The synchronization is easier with one controller because all the data is on one CPU. That also saves cabinet space."

The savings in hardware can include everything from PCs and controllers to wires. "You have less hardware and more software now. That's efficient," Harris told us. "You have only one cable, while traditionally, it was dual cables. So you have less material. Safety is now integrated into the same Ethernet bus as the controller. That offers savings in set-up."

Safety and simulation

Safety has become significantly more efficient. For one, you can run safety on the same wire as control and power. For another, safety breeches don't have to bring down the whole plant. "We have safety in zones now. We have the ability to just stop the zone when there is a safety infraction," Patrick McDermott, regional manager at B&R Industrial Automation, told Design News. "We don't have to stop everything. We're going to programmable safety."

Simulation has also brought efficiency to plant processes. Changes can now be worked out in simulation before you turn on machines

that might crash into each other if you don't work out the configuration ahead of time in software. "Technology also means I'm not rewiring when I make a change. I'm changing the code instead. It's configuration, not design and rewiring," said McDermott.

The simulation means changes can

be made both accurately and quickly. "One factor is time-to-market. Simulation allows machine builders to minimizing time on the machine," McDermott told us. "You can spend your programming time up front. That minimizes time on the machine."

Employee buy-in

Another way to make sure efficiency really takes hold in a plant is to get employee buy-in. You get the buy-in by involving employees in the efficiency process. "It starts with getting people to understand there is always room for improvement. You have to embrace all employees," Jim Coshnitzke, a manager at Clippard, told Design News. "You get people in production, supervision, and management, and you map the current cycle. You model it and get input from everyone."

"That input from everyone can be as little as changing the work set-up to make production movements more efficient. It may not seem like much when you save a handful of seconds, but they can add up to real savings. You look at what steps you can change. You rearrange tools to make movements easier. You save 15 minutes. You add it up and it saves hours," said Coshnitzke. "You work on those ideas. But in order to get the employees' ideas, you have to have employee buy-in."

The employee input can be as little as saving movement or as large as changing the fundamental manufacturing process. "In one instance, we compared batch to process. We had been doing batch. So we took all of the employees and took them through a Lego exercise," said Coshnitzke. "We did batch, and then we did flow. We saw a 300-percent improvement with flow. Everyone was involved, so we have the buy-in to switch from bath to flow." ■

Clippard Instrument Laboratory has been Providing Quality Miniature Pneumatic Products for Over 60 Years

Clippard Instrument Laboratory, Inc., Manufacturers of Pneumatic & Electronic Control Devices

History

William L. Clippard, Jr. founded Clippard Instrument Laboratory in 1941. The initial product line consisted of electrical test equipment, magnetic windings, and radio frequency coils. The first miniature fluid power devices designed and built by Clippard were for use in the manufacture of this equipment. In the early 1950's, Clippard introduced Minimatic® components as a new product line. The need for miniature pneumatics was so widespread, that the Minimatic line was successful enough to become Clippard's primary product line.

Today, Clippard pneumatic control devices are used virtually everywhere for control, interface, sensing, logic, and actuation functions. This broad range of applications spans a variety of industries including machinery, textiles, medical equipment, animation, material handling, assembly, electronics, food processing, packaging and many more.

Milestones

For over 60 years, Clippard innovation has led to many industry "firsts," such as the establishment of the #10-32 thread as a port. Products that Clippard first introduced to the industry include: fluidic amplifiers, unique plug-in air logic modules, and micro-processor-based computer control systems. The complete Minimatic line includes over 5,000 standard products. Some of the many products offered include valves, cylinders, fittings, modular components, push buttons, stainless steel cylinders, FRLs electronic manifold cards, circuit analyzers and pre-piped manifold subplates. The latest additions to the Clippard product line include: Jumbo Shuttle Valves, New Series Needle Valves, Minimatic Shuttle Valves, Normally-Open Valves with 1/8 NPT Male Inlets, Pilot Actuated Valves, All Stainless Steel Cylinders and Minimatic Air Regulators. Special components

The complete Minimatic line includes over 5,000 standard products

designed for customer's OEM applications are also available.

In 1973, Clippard introduced the EV line of miniature electronic valves. What made this valve so unique was that it only had one moving part, the "spider". Today, the EV line is still serving a very horizontal market with thousands of installed applications in hundreds of industries. Since the initial introduction, several new series have been added to the line, including: Corrosion-Resistant, Oxygen Clean, Analytical, High Flow, Proportional Control, Intrinsically Safe, EM and ES series, all utilizing the "spider" design.

In May of 2006, Clippard launched an all-new line of miniature pneumatic products, The Maximatic® line. Maximatic solenoid valves, air piloted valves, and FRL's feature maximum performance and maximum value. The valves are available in port sizes from #10-32 to 1/2" NPT, and FRL's from #10-32 to 1" NPT with various options for users in the packaging industry, assembly, manufacturing and more.

In May of 2014, Clippard released the first 2-way version of the newest line of miniature electronic valves—the DV series. With low power, compact design, high flow, design flexibility and more, these valves utilize a very different "spider" design, and have many new features that offer tremendous market potential.

Web

Visit www.clippard.com to find product and industry information including specifications, CAD files, literature downloads, application ideas, instructional/technical videos, helpful calculators, technical assistance, distributor information and more.

Quality

Quality remains a primary feature of every product Clippard produces. This is achieved through the excellence in manufacturing practices and craftsmanship that has continued throughout the years. The high standards set by Leonard Clippard, in company relationships with customers, distributors, suppliers and employees continue to be upheld. The company motto, "Quality People, Quality Products", emphasizes the important role every employee plays in maintaining the company's reputation.

ISO Certification

Clippard Instrument Laboratory, Inc. is ISO 9001:2008 certified, an internationally recognized standard issued to organizations with a quality management system. The certification was authorized by TÜVRheinland® (TRNA), a premier global provider of independent testing and certification services with 15 locations throughout North America.

ISO 9001:2008 provides a set of requirements that must be in place to have a quality management system, regardless of the organization's size, product or service line, or public or private status. Certification to the standard is voluntary, and organizations must complete a rigorous auditing process by a third-party registrar.

Catalog

Clippard offers a full-line catalog that contains over 5,000 standard products including photos, technical specifications, schematics, application and ordering information, and more. Request catalog.

Distribution

A fully-trained, professional distributor network markets and supports Clippard products, worldwide. To assure quality performance, close customer contact is maintained through a network of over 80 stocking distributors, with over 800 pneumatic specialists. Clippard maintains close ties with these distributors through special conferences, training seminars and the complete support of the factory sales and service team.

Recent New Product Announcements

Over the past several months, Clippard has continued to release new, innovative products to the market.

Some of the most recent releases include:

- **EFG Electronic Fill & Bleed Circuits** – Compact, robust design with multiple flow and pressure options.
- **EGV High Flow Poppet Valves** – 2- and 3-way, 1/8" NPT ported and manifold mount. Utilize Clippard 10 mm and 15 mm valves.
- **All Stainless Steel Cylinders** – 303 and 304 stainless cylinders available in four bore sizes with standard strokes to 12".
- **GV/GTV Poppet Valves** – Small size, high flow and multiple styles!
- **Multi-Check Valves** – Efficient manifold mounted design eases assembly and plumbing!
- **DV Bidirectional Electronic Valves** – Offers sleek, compact design, high flows, low power and competitive pricing!
- **GNV Series Needle Valves** – Rugged, compact design provides bidirectional flow control. ■

Clippard Instrument Laboratory, Inc.
7390 Colerain Avenue
Cincinnati, Ohio 45239
877-245-6247
www.clippard.com

Clippard 2-Way High Flow Stepper-Controlled Needle Valves

Utilizing the industry's most robust and powerful linear actuator, this high-flow proportional valve features 2% hysteresis, excellent linearity and a 2 ms reaction time. A flow range of 0 to 300 slpm is standard, however this product is highly modifiable.

Clippard Launches Exciting New DV Series Electronic Valves

Clippard launches exciting new DV-Series bidirectional electronic valves which offer sleek design, low power, high flow and more!

Clippard EVPD Proportional Valve Driver

The EVPD Proportional Valve Driver is an interface device to control Clippard EVP Proportional Valves with signals that are typically available from micro-controllers, PLCs and industrial computers. It generates a high power output current to drive the proportional solenoid valve in response to a low power proportional command signal.

Clippard Automated Acoustic Guitar

Clippard's Automated Air Guitar is a pneumatically controlled Ovation. Created to show our capabilities in pneumatic control applications. Over 16 songs play during specific trade shows to let people know about Clippard's products, capabilities and creativity.

Air Guitar Retuned by Clippard's Pneumatics

Charles Murray, Senior Technical Editor, ***Electronics & Test,*** February 22, 2012

Pneumatic technology is usually associated with machine control, but at the Medical Design & Manufacturing West Conference in Anaheim, Calif., it was about music.

Clippard Instrument Laboratory Inc., a maker of pneumatic components, demonstrated a guitar that employs 62 air cylinders and 62 pneumatic valves to play music. The brainchild of company namesake Rob Clippard, the guitar uses a combination of 5/16th-inch and 5/32-inch air cylinders to strum its six strings. It also employs a half-inch-diameter cylinder to provide an "acoustic thump" for the music.

"Rob's musical, and he grew up with Clippard technology, so he just combined the two," says Edward Ehrhardt, sales application engineer for Clippard.

The Air Guitar plays Rob Clippard's own original songs, which

Clippard's air guitar uses a combination of 5/16-inch and 5/32-inch air cylinders to strum its six strings.
A half-inch-diameter cylinder provides percussion.
(Source: Clippard Instrument Laboratory Inc.)

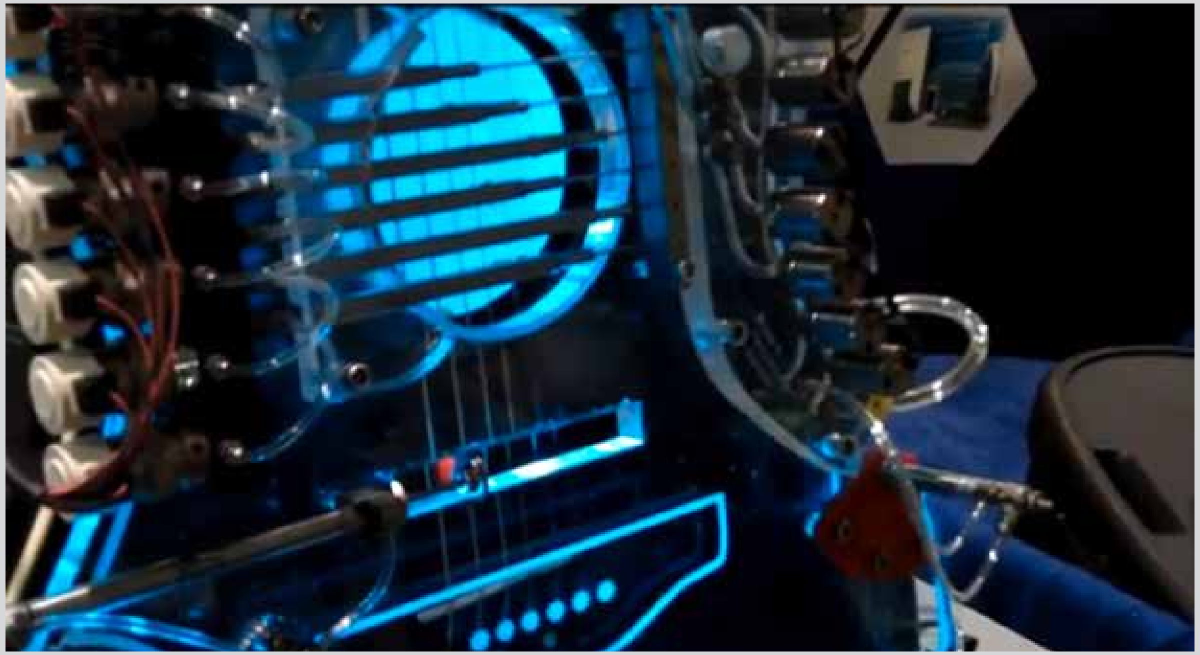
are encoded in MIDI (musical instrument digital interface) protocol files. The files are communicated from an iPad to a microcontroller-based I/O board, which decides which valves to fire.

At the show, the Air Guitar drew crowds as it played a running loop of Rob's music.

The Air Guitar isn't his first foray into pneumatic music. He previously designed a 6-foot-diameter "music tree," which employed air to play strings, whistles, and cow bells. The musical tree is now housed at the Cincinnati Museum of Natural History. ■

Air Guitar Videos

Here's a video shot by the author at the MD&M conference:



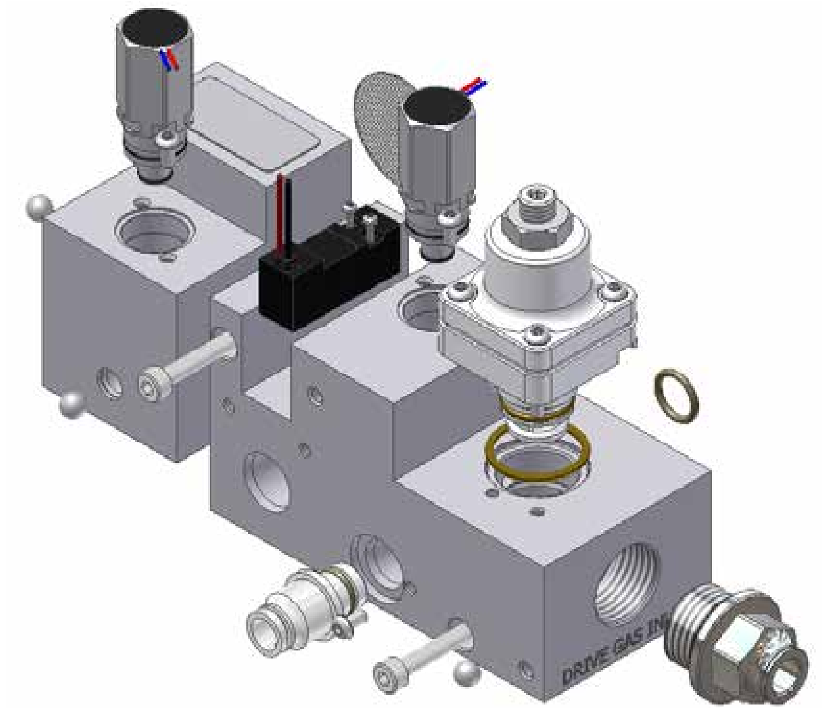
VIDEO: This video, produced by Clippard, spotlights details of the guitar's fretboard:

Pneumatics in Small Medical Devices

Al Presher, Contributing Editor, ***Automation & Control,*** **January 5, 2011**

With the design of medical devices moving toward smaller sizes, a hospital-to-home treatment model and reduced power consumption, electro-pneumatic device makers are seizing the opportunity by providing more potent, miniaturized control solutions. By using proportional control to precisely profile the delivery of air, for example, pneumatic devices are solidifying their position as a low cost technology ideal for a wide variety of handheld and portable medical devices.

"There is a lack of awareness of how pervasive the pneumatic solutions are in medical applications," says Ed Howe, president of Enfield Technologies. "Most people don't realize how much pneumatics is used in surgical and life support equipment. In the artificial heart made by SynCardia, for example, basically the whole drive system is pneumatic and some of the components are similar to what is being used in factory automation."



Rise of Proportional Control

One clear trend is the move to proportional control and electro-pneumatics for more precise control solutions. Howe says that with devices such as ventilators or respirators, the operation of units in the past has been largely on and off, pushing a breath in and taking a breath out. But now medical device manufacturers are using pneumatics to profile the breath provided to the patient to be more natural and assist in the recovery process.

"We are working on a ventilator that will work with infants through adults, so that when it's used in an ambulance, air care helicopter or within a hospital, there isn't a need for two expensive devices," says Howe. "The unit uses a proportional servo valve with embedded electronics and software, and it has a very specialized shape to the orifice and poppet - all together these carefully control the air flow."

Another application using proportional pneumatic controls is the process of growing cells either for biomedical research or transplants such as bone marrow cells. Grown in a Petri dish, the yields are very low. But researchers discovered that putting the cells on a flexible membrane and pulsing the membrane, stresses and pulls the cell. It's not certain how growth is encouraged but the obvious theory is that cells recognize the motion and, surrounded by other cells, sense it is in a living host.

"Using a very smooth and fast valve, we are able to replicate the heartbeat of the host animal rather than just turning the valve on and off," says Howe. "We are even able to perfectly replicate the heartbeat of a hummingbird. This is an example of pneumatics bringing real benefits to the medical field by doing things that couldn't be done before. In this case, we are substantially increasing yields."

Growth of Pneumatics

The underlying theme to this transition is the use of more proportional pneumatics and better use of control theory.

Mechanical elements in the valves are becoming more sophisticated, along with better design tools and mathematical modeling. Systems are using more sensors, electronics and advanced controls to manage pneumatic systems and compressed gases, which has always been the real challenge.

"Pneumatic systems are able to profile the air and deliver it in a more natural way," says Howe. "Along with the air pressure profiling, systems consume less air by only providing what is needed and lower the wear on components, but the big developments are linked to therapeutic contribution."

Compared to the past where respirators used large glass tubes with bellows and were primarily electric systems, respirators now use compressed air in a small cylinder, or a small compressor and valves, to modulate a system where the devices have been miniaturized.

Another proportional valve application is controlling the pressure of a ventilator that is actually breathing for patients. These more sophisticated ventilators provide pressure control or PEEP (positive end-expiratory pressure), which allows the ventilator to be more effective in the transfer of oxygen into the nodules of the lungs that complete the transfer of oxygen into enriched blood.

"With PEEP, the pressure control device makes the ventilator more effective by using proportional controls to vary the pressure as the ventilator expands the lungs," says Rob Clippard, vice president, sales & marketing for Clippard Instrument Lab.

Electro-pneumatic systems are also being used in automated blood pressure monitoring devices where a valve both inflates the cuff and controls the rate of deflation. The electronic valve is cycling on and off, and the pressure drops as the device exhausts the air in the cuff. Valves used on these more sophisticated blood pressure monitoring devices not only recognize systolic and diastolic pressures, but actually measure the point at which the blood begins flowing.

"When the cuff is inflated, the blood vessels are restricted and create a tourniquet," says Clippard. "When the pressure is slowly released, there is a point at which some of the blood vessels release and blood starts to flow."

Sophisticated devices use techniques to notice how quickly the blood flow recovers and use that information to diagnose different maladies with the patient. The devices use very precise pressure control, versus a device which turns on and off, and provide a gross control. The proportional valve allows the application to inexpensively add fine pressure control at the point where those blood vessels are just beginning to open and blood is beginning to flow.

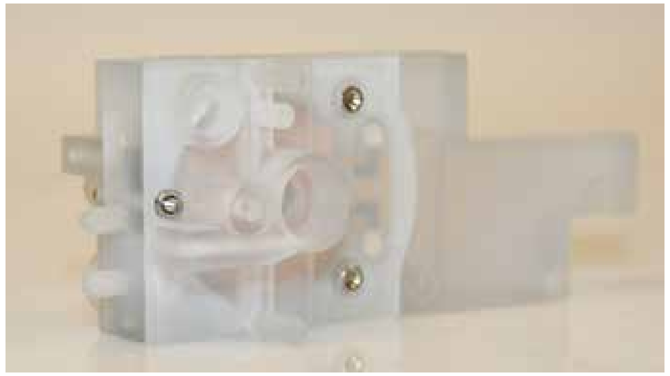
Designers Focus on Size and Power

In pneumatics for medical applications, the trends are mirroring the changes in the medical devices themselves. One trend is portability and movement where in the past the focus was more on in-hospital treatment. Now there is a clear shift to more out-of-the-hospital and home clinical treatment.

"What we are seeing with medical devices is that they're getting smaller and are often made to be ambulatory where they need to be disconnected from the wall for the patient to be able to move around," says Randy Rieken, sales leader, Americas for Norgren Life Sciences.

In some cases, there is a need for the patient to take the device home. A patient might use a ventilator in the hospital, and the same device might be taken home by the patient and used remotely. With the devices getting smaller and the requirements for pneumatics changing, components are getting smaller and power consumption is an important design issue. Audible noise levels are critical because, if a patient takes an O2 concentrator or ventilator home, they don't want to hear the valves actuating.

"Because the components are



smaller, issues such as accuracy and reliability are even more important," says Rieken. "The flow capabilities of valves, even though they are getting smaller, are often the same as before. Medical device manufacturers are looking for higher performance components in a smaller package."

Rieken says it used to be that miniature valves were 16 mm, and then 10 mm. But now many are 8 mm and there is work on valves in the 4 to 5 mm ranges. At some point as devices continue to get smaller and smaller, the actual technology may change but now valves are still using the same technologies. The current goal is to miniaturize and optimize designs to be smaller but, in the future, technologies such as shape metal alloys and piezo actuator technology may come to the forefront as devices get smaller.

One area where pneumatics continues to provide effective components for portable devices is ventilator products. We may think of a big ventilator next to a patient's bed, but units are becoming smaller and some companies are targeting the C-PAP market (devices that help patients with sleep apnea breathe properly while asleep), where the patient can wear the ventilator on their waist or carry it in a small bag. With oxygen concentrators, devices often weigh five pounds and less and the size of the pneumatics internally is a huge consideration.

"The design focus in on size and power, and there are things you can do with power," says Rieken. "We actually have a PWM (pulse width modulation) valve with a processor that can detect when the plunger is moving to optimize the power but most design decisions are based on the size of the device and battery usage. An oxygen concentrator may need a 12-hour battery life and, if there are four valves in the unit, they need to be extremely low power."

One area where suppliers are concentrating to provide greater value to customers is engineering expertise specific to applications. The device manufacturer comes with requirements, schematics and a willingness to consider more highly integrated pneumatic modules. Often these modules include flow control, filtration, switching valves, fittings and safety relief valves all manufactured specifically for the application and designed into a compact, optimized module that is fully assembled and tested.

Energy-Efficient Piezo Solutions

"In handheld instrumentation and medical devices, power budgets are being scrutinized more than ever, as a result of a delicate balance between added functionality and power consumption," says Richard McDonnell, piezo products program manager for Parker Hannifin Corp.

As portable or handheld analyzers continue to shrink in size and device functionality continues to increase, customers are expecting next-generation products to operate longer between battery charges. In the past, instrument engineers might have considered using a hit-and-hold circuit to reduce a valve's power consumption which uses a higher voltage to open the valve and then a lower voltage to hold it open. Power consumption is decreased, but it is not as efficient as piezoelectric valves.

But McDonnell says that option is no longer good enough. For example, one client cited that in an application of two 0.5W valves, the valve's parasitic power loss was second only to the instrument's cooling fans. New piezoelectric actuator technology enables the valves to operate in the 100 mW range and, coupled with negligible heat generation, self-latching function and the ability to stay in position without power being applied, are reasons for growing interest in piezoelectric technology.

"How that relates in the world of pneumatics is to provide customers with multi-function valves. It was that idea that led us to developing advanced piezoelectric actuator technologies to augment or perhaps even replace solenoids in the future," says McDonnell.

Parker has opted to develop its piezo technology around two types of actuators: a 25 mm round, short stroke, low force RLP actuator and its ViVa, a family of actuators with mechanical amplification for applications requiring large displacement and high force. Either type can be used as an independent actuator or as an alternative to solenoid and voice coil type actuators.

McDonnell says Parker's compliant actuator design increases the piezo displacement well beyond the traditional stack-type piezo, while generating more exploitable forces when compared with Bender-type piezo actuators.

"Because the ViVa actuator is inherently proportional, we can apply the technology in a variety of applications to precisely profile the delivery of compressed air or gases while minimizing power consumption," says McDonnell. He says that there is also significant interest in energy recovery and ultra-low-power technology with energy harvesting to create energy independent systems. ■

Energy Efficiency Depends on the Application

Jack Mans in Automation, *Packaging Digest*, March 31, 2013

It is not possible to provide a simple answer to the question of whether a pneumatic drive is more energy-efficient than an electric drive or vice versa. "Energy efficiency in automation is dependent on the industrial application", explains Roland Volk, energy efficiency consultant. Only a direct comparison of two equally dimensioned drives - one electric and one pneumatic - is able to dispel the prejudices associated with this question.

First of all: the truth as to which drive is the most energy-efficient lies, as always, in the middle. Energy efficiency is totally dependent on the purpose for which the drive is used. Measurements reveal the following differences: for a simple motion task, an electric drive is cheaper. During press operations, the level of process force and the duration of the operation decide which technology is more efficient. However, if the application requires a holding force, pneumatics is clearly at an advantage.

In this comparison, motions are performed from point A to point B. These motions can be performed in almost all cases by pneumatic drives. Nevertheless, electric drives are commonly used to provide such simple motions. If, on the other hand, an application requires free and flexible positioning, electric drives are more advantageous.

Moving a workpiece or holding it?

These two functions result in very different energy consumption values. In the case of motion without additional process force, an electric drive consumes only one-third (25 Ws) of the energy that a pneumatic drive needs (78 Ws). For the function of pressing with process force, both drives have roughly the same energy consumption of between 20 and 30 Ws.

If, however, the drives are required to hold a certain position, the energy consumption of the electric drive shoots up to 247 Ws. This is more than 22 times as much as the energy consumption of the pneumatic drive (11 Ws). The pneumatic drive benefits from the fact that it requires energy only for the brief moment in which pressure is built up. The holding process itself can be carried out completely without any fresh compressed air supply. The electric drive, on the other hand, requires electricity constantly in order to remain in the desired position. The longer the holding process continues, the higher the energy consumption of the electric drive compared to the pneumatic drive. Measurements show that minor leakages have practically no influence on the low energy consumption.

Taking a close look at grippers

A comparison of electric and pneumatic grippers produces similar results. The comparison shows how finding the right solution depends on a clear definition of the application. If we consider the energy consumption during the gripping process, a pneumatic gripper is superior to an electric gripper in application with long cycles and with few gripper operations.

A pneumatic gripper requires pressure only once for continuous holding. No more pneumatic energy is then required for the duration of the holding operation. An electric gripper, which needs electrical energy for the entire duration of the holding operation, can be more energy efficient than a pneumatic gripper only if the application consists of short cycles with a large number of gripping operations.

It all depends on the application. Any industrial application has its own specific requirements regarding technical criteria such as speed, load capacity, power to weight ratio, accuracy, control behaviour, rigidity under load, efficiency and robustness, as well as economic criteria such as acquisition costs (purchase price, costs of installation and commissioning) and operating costs (maintenance, service life, energy costs).

Energy efficiency depends on the application. “This must be clearly defined before a user chooses the drive technology - electric or pneumatic or a mixture of both,” explains Volk. Technologies can be compared only on the basis of the total costs of ownership (TCO), which take into account both the acquisition costs and the energy costs. ■